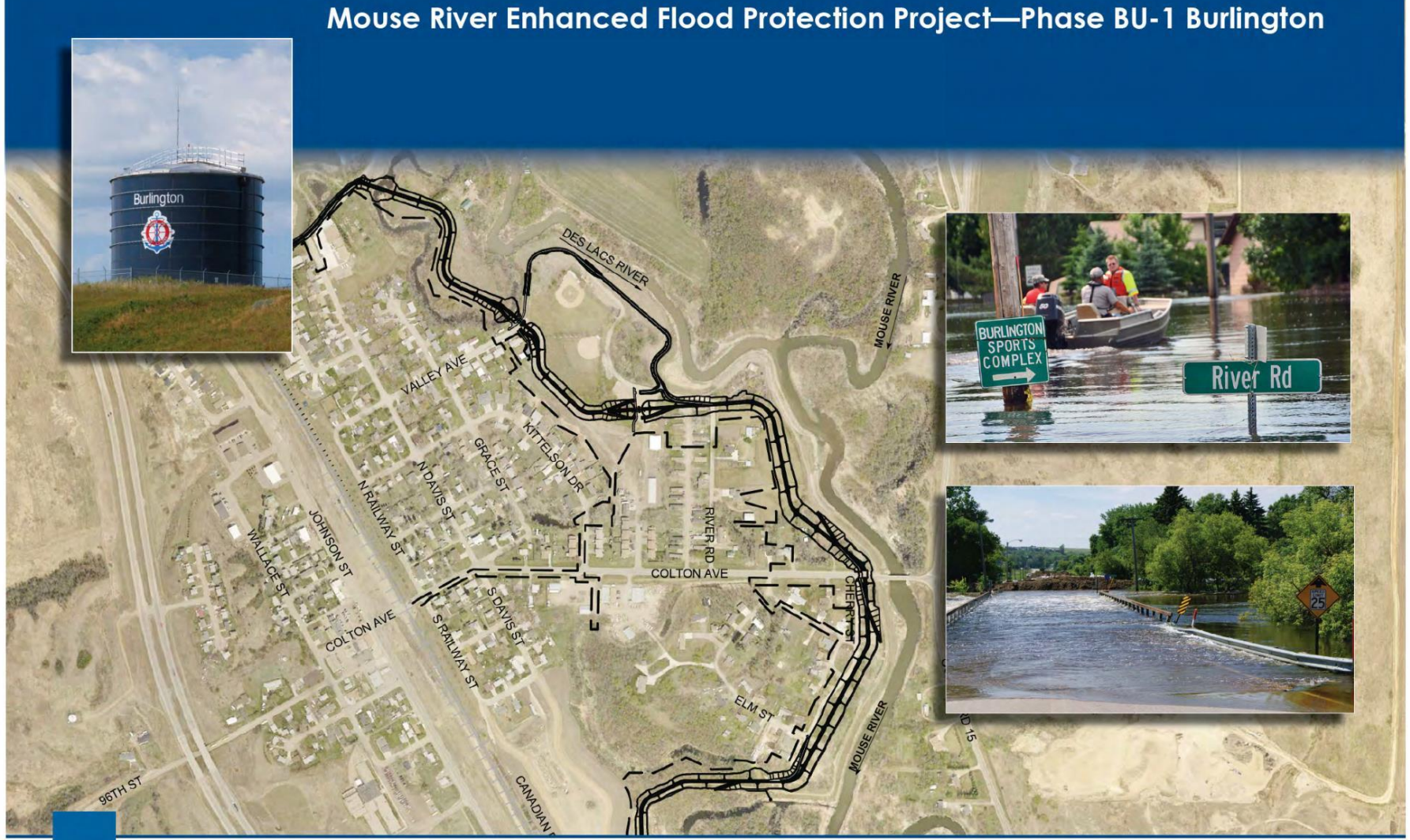

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Tom Johnson, PE, CFM

March 7, 2018 -AMFM

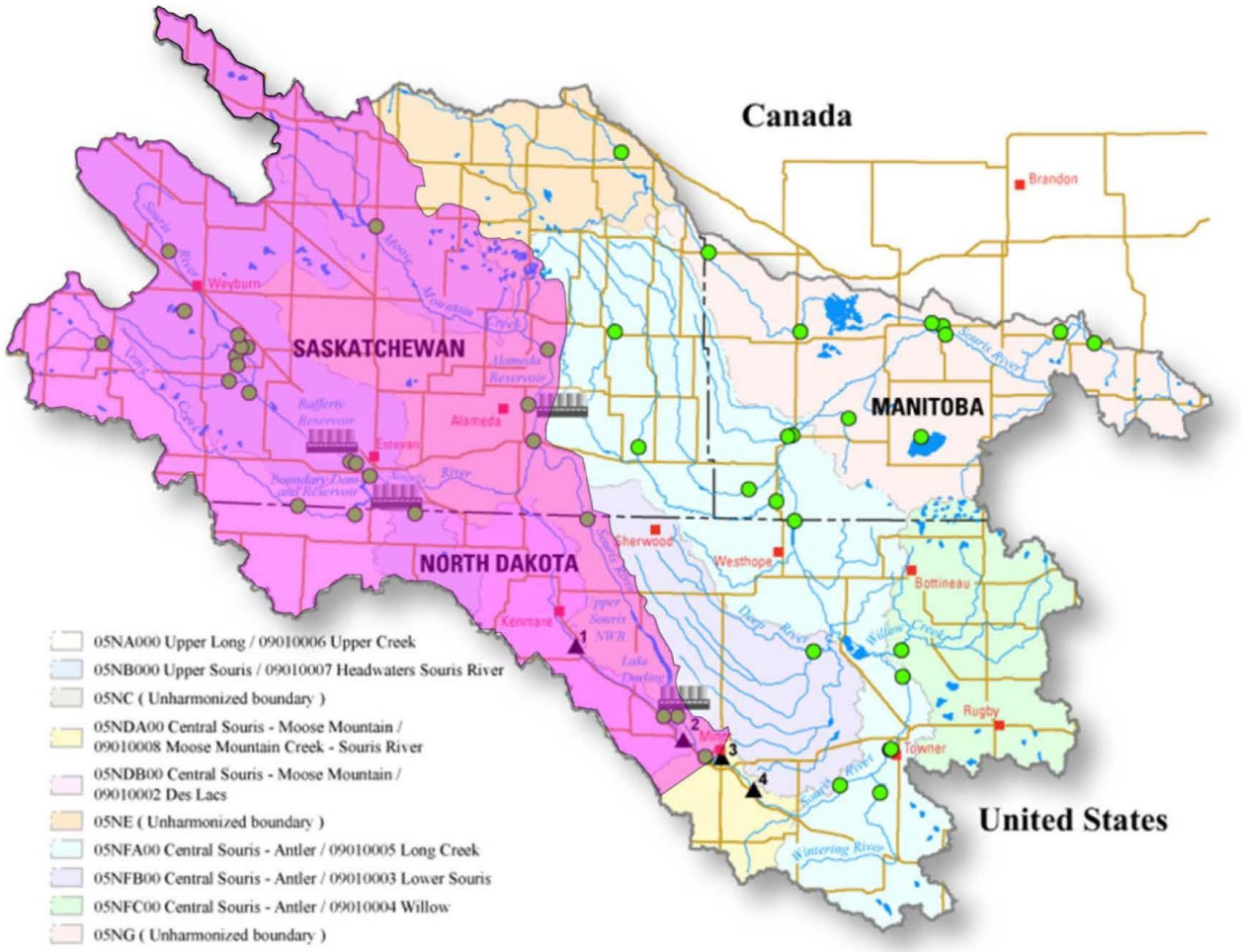
City of Burlington, ND
Interior Drainage Design

Burlington, ND Interior Drainage

- Background
  - Mouse (Souris) River Basin
  - 2011 Flood – Mouse River
  - Mouse River Enhanced Flood Protection Project
  - Preliminary FIRMs
- City of Burlington
  - Preliminary Engineering Report (PER)
  - Existing Interior Drainage
- Interior Drainage
  - PER, 60%, 90% Design
  - Cost Analysis
  - Additional Factors

Watershed Above Minot

Mouse (Souris) River Watershed



Mouse/Souris River Basin

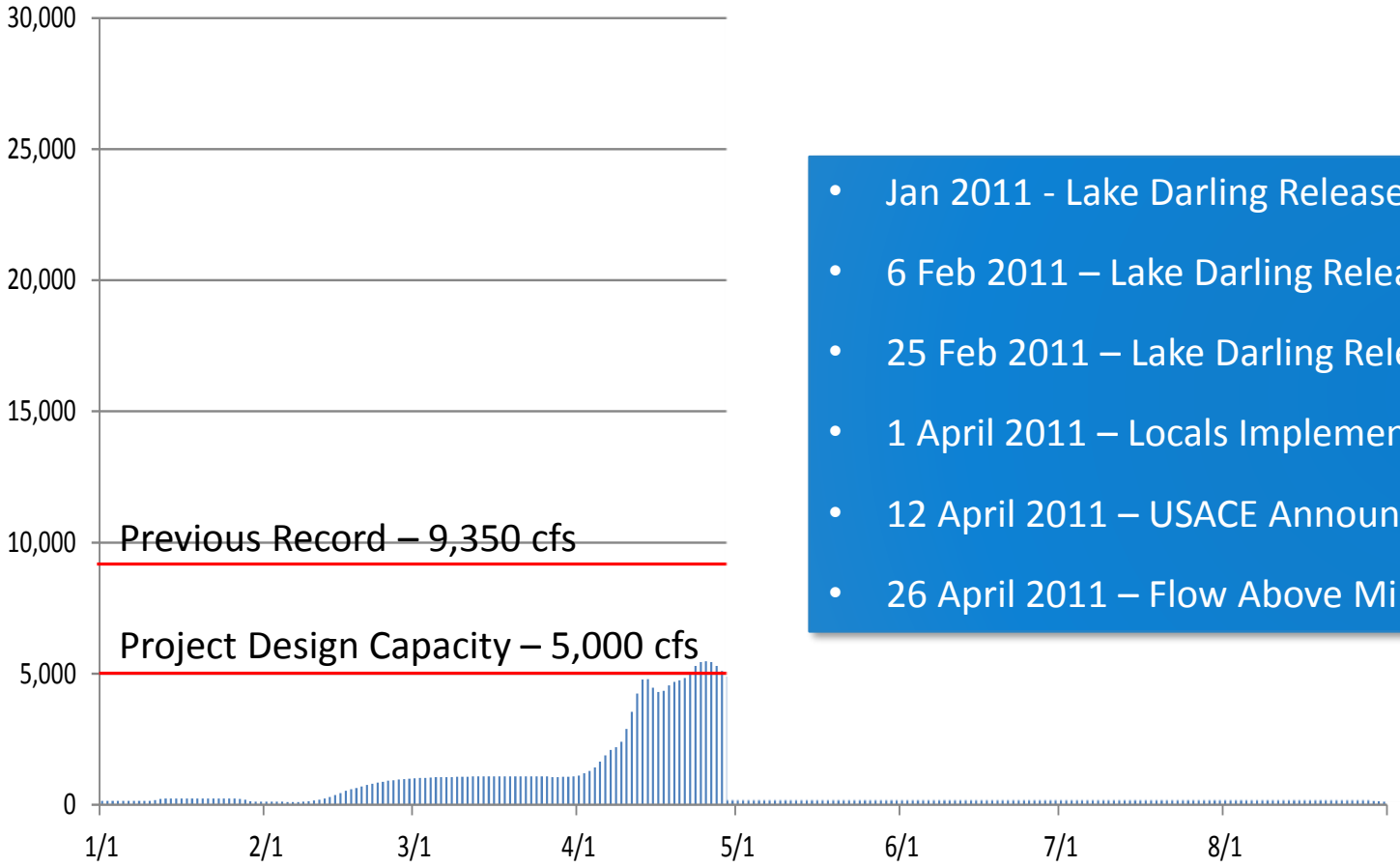
Rafferty Dam

Boundary Dam

Alameda Dam

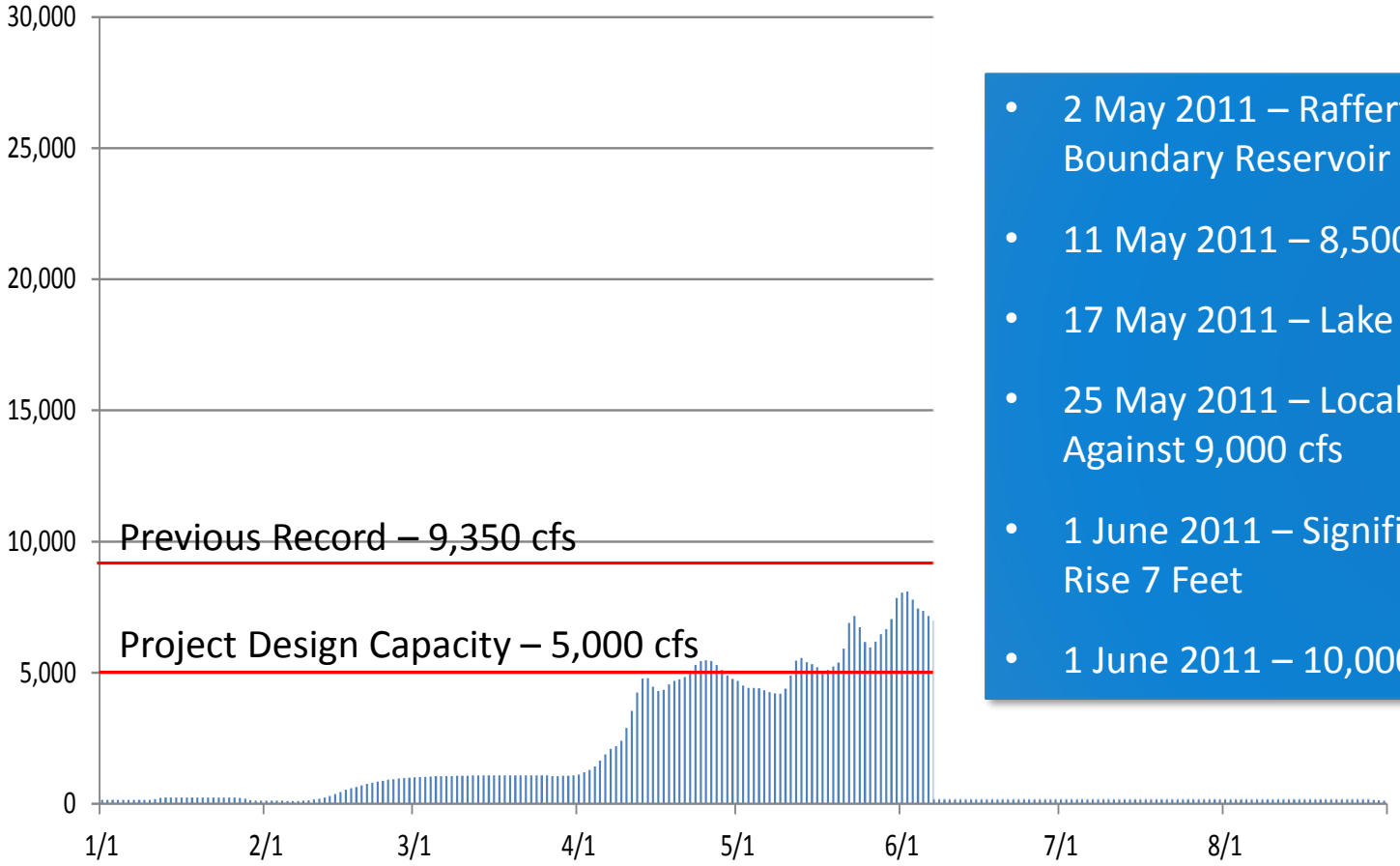
Lake Darling Dam

Recap – January to April 2011



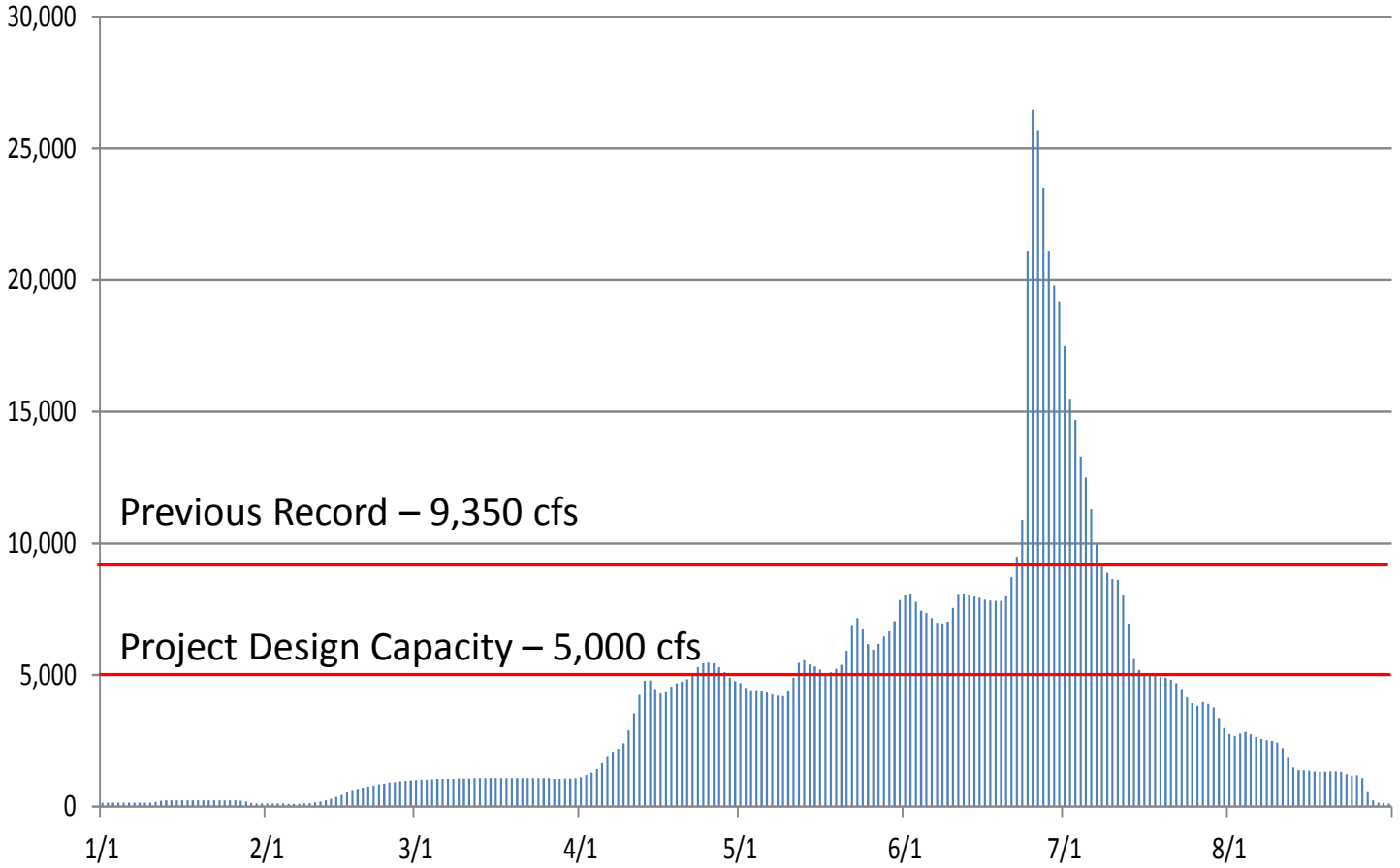
- Jan 2011 - Lake Darling Releases 200 -450 cfs
- 6 Feb 2011 – Lake Darling Releases 600 cfs
- 25 Feb 2011 – Lake Darling Releases 1,100 cfs
- 1 April 2011 – Locals Implement Plans for Protection Against 7,000 cfs
- 12 April 2011 – USACE Announces Target Flow of 5,000 cfs at Minot
- 26 April 2011 – Flow Above Minot Reaches 5,440 cfs

Recap – May to June 2011



- 2 May 2011 – Rafferty Reservoir Within 2 Feet of Spillway; Boundary Reservoir Within 0.2 Feet of Spillway
- 11 May 2011 – 8,500 cfs Out of Saskatchewan
- 17 May 2011 – Lake Darling Releases 4,800 cfs
- 25 May 2011 – Locals Implement Plans for Protection Against 9,000 cfs
- 1 June 2011 – Significant Rainfall Causes Des Lacs River to Rise 7 Feet
- 1 June 2011 – 10,000 Minot Residents Evacuated

Recap – June to August 2011



- 6 June 2011 – Minot Evacuation Order Lifted
- 6 June 2011 – Lake Darling Releases 7,500 cfs
- 17 June 2011 – 7 Inches of Rain Above Rafferty Reservoir Near Weyburn
- 22 June 2011 – Mandatory Evacuations Ordered
- 24 June 2011 – Lake Darling Releases 26,000 cfs
- 25 June 2011 – River Crests in Minot at 27,400 cfs

2011 Mouse River Flood

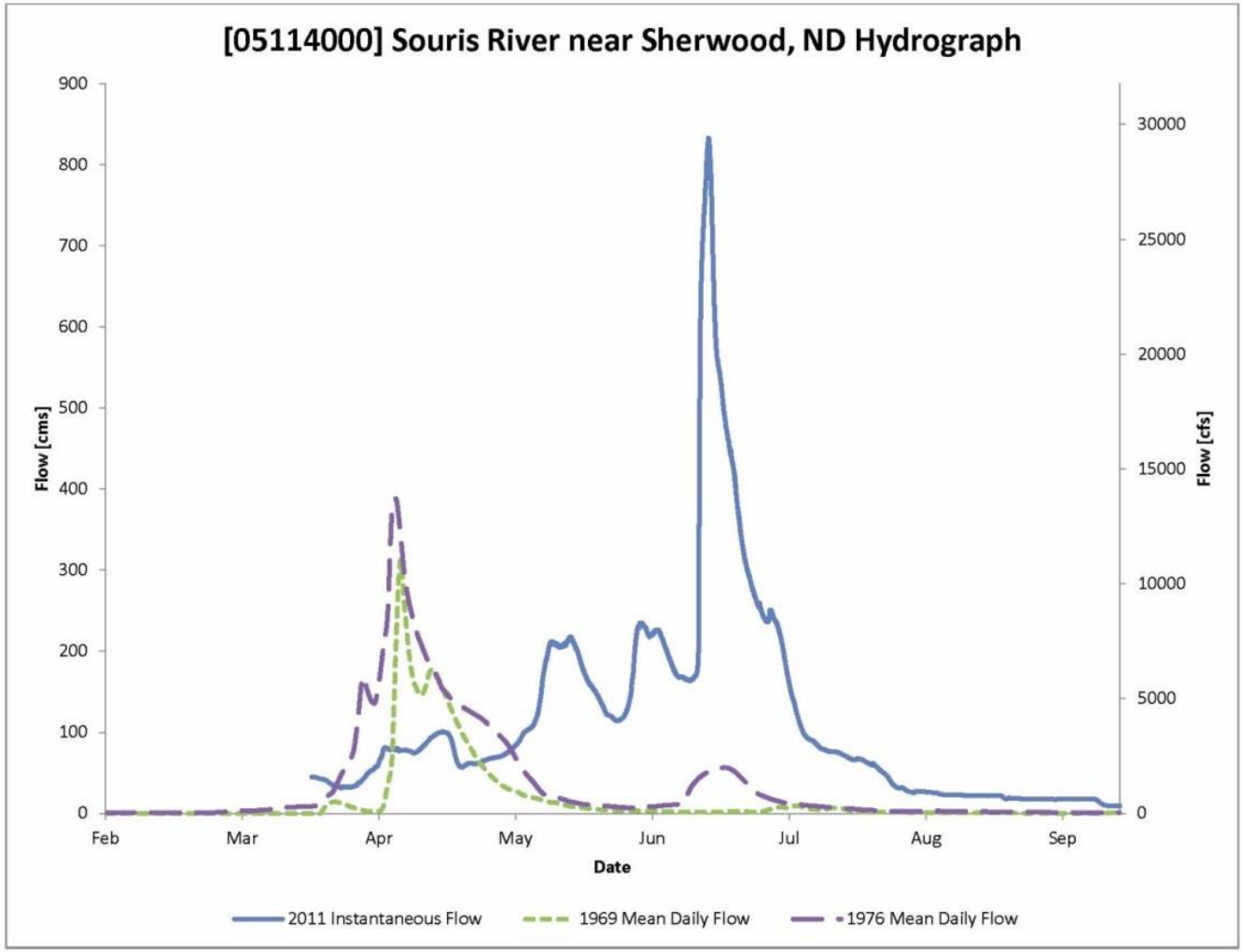
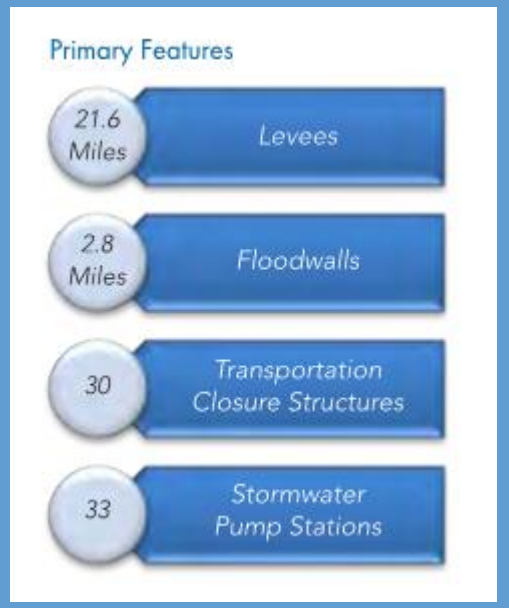


Figure 3-22: 2011 Flow Hydrograph, Souris River near Sherwood, ND

Introduction to the MREFPP

- Mouse River Enhanced Flood Protection Project
- SWC & Souris River Joint Board
- Urban and Rural Solutions
  - Urban Features
  - Rural StARR Program, Bridges/Roads, Trapped Water
- $1 Billion



BASIN-WIDE IMPROVEMENTS

BENEFITING RENVILLE, WARD, MCHENRY AND BOTTINEAU COUNTIES

Renville County Projects (Thru 2039)		
R1	Rural Structure Acquisition, Relocation or Ring Dike	$2 M
R2	Mouse River Park Levee Improvements	$21 M
R3	Lake Darling Dam Operational Modifications	$3 M
R4	Rural Bridge / Road Modifications	$13 M
R5	Remove Trapped Water	$1 M
	Renville County Subtotal	**$40 M**

Ward County Projects (Thru 2039)		
W1	Rural Structure Acquisition, Relocation or Ring Dike	$25 M
W2	Burlington Levee System	$36 M
W3	Robinwood / Brooks Addition Levee System	$59 M
W4	Talbott's Levee System	$7 M
W5	King's Court Levee System	$17 M
W6	Tierracita Vallejo Levee System	$17 M
W7	Minot Levee System	$564 M
W8	Apple Grove Levee System	$25 M
W9	Eastside Estates Levee System	$13 M
W10	Sawyer Levee System	$28 M
W11	Rural Bridge / Road Modifications	$40 M
W12	Remove Trapped Water	$1 M
	Ward County Subtotal	**$832 M**

McHenry County Projects (Thru 2039)		
M1	J. Clark Salyer Structure Modifications	$21 M
M2	Rural Structure Acquisition, Relocation or Ring Dike	$5 M
M3	Velva Levee System	$21 M
M4	Rural Channel Modifications	$15 M
M5	Rural Bridge / Road Modifications	$21 M
M6	Remove Trapped Water	$3 M
	McHenry County Subtotal	**$86 M**

Bottineau County Projects (Thru 2039)		
B1	J. Clark Salyer Structure Modifications	$32 M
B2	Rural Channel Modifications	$17 M
B3	Rural Bridge / Road Modifications	$21 M
	Bottineau County Subtotal	**$70 M**

GRAND TOTAL: $1.028 BILLION

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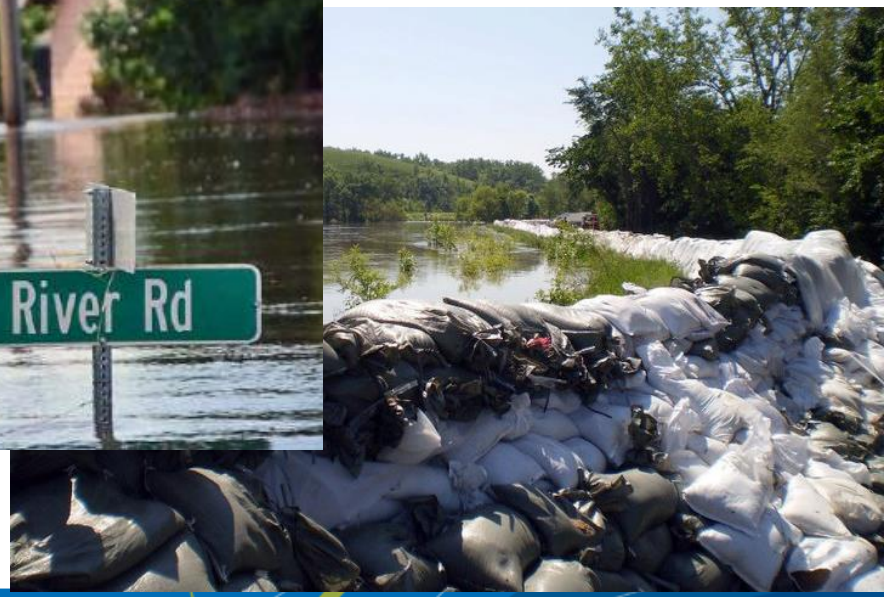
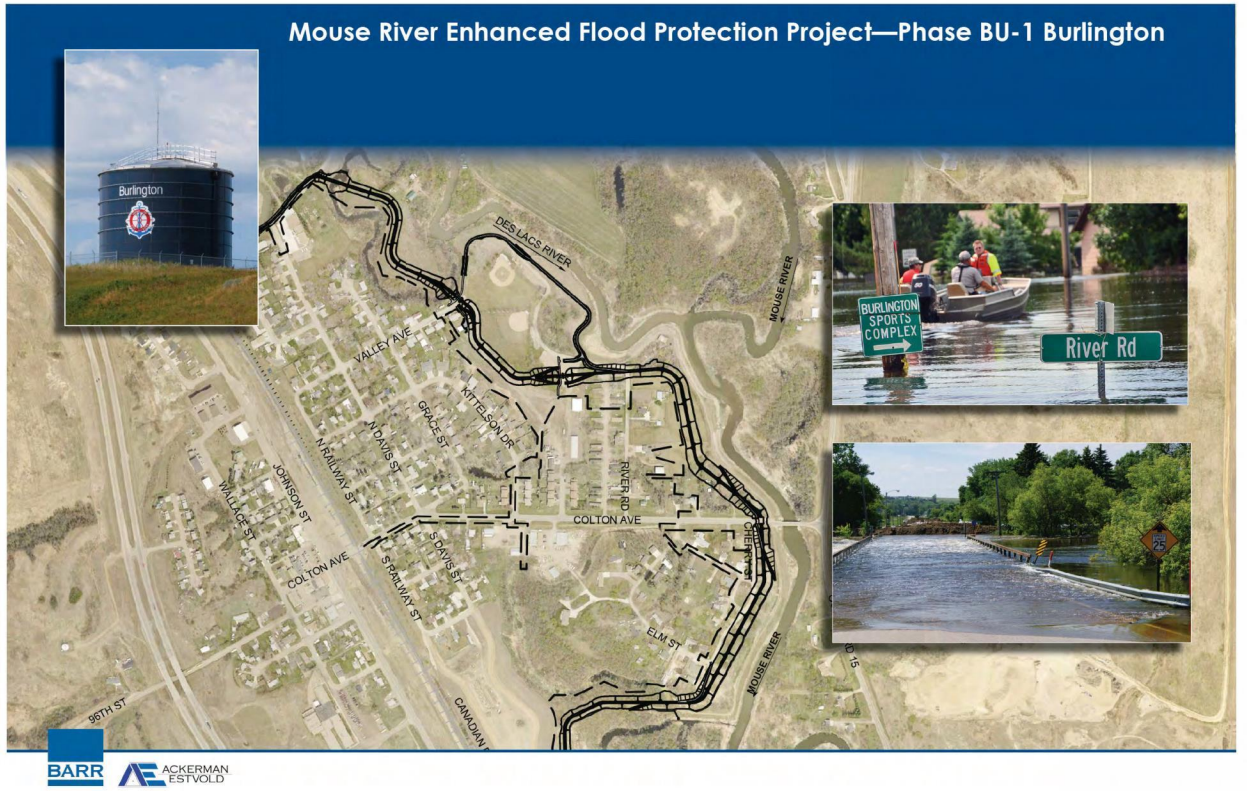
2011 Mouse River Flood - Burlington



Burlington Interior Drainage

- Preliminary Engineering Report / 30% Design
- 60% Design – 2 Pump Station, Gravity System
  - Pros and Cons
- Spring 2017 Operations – Lessons Learned
- 90% Design – 1 Pump Station, Force Main Only
- Concerns Being Addressed in Final Design



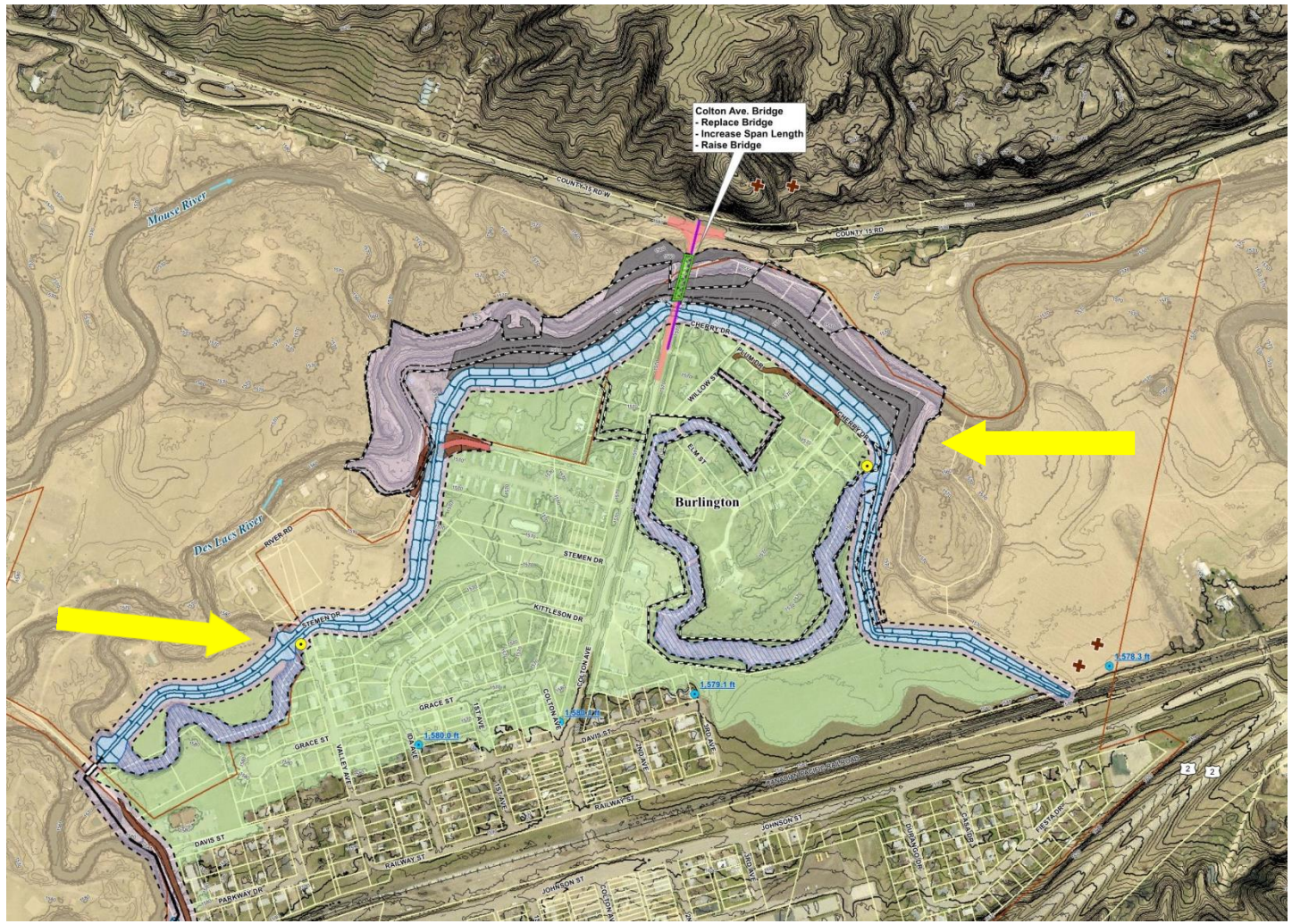
PER Solution for Burlington Levees

River Flood Protection

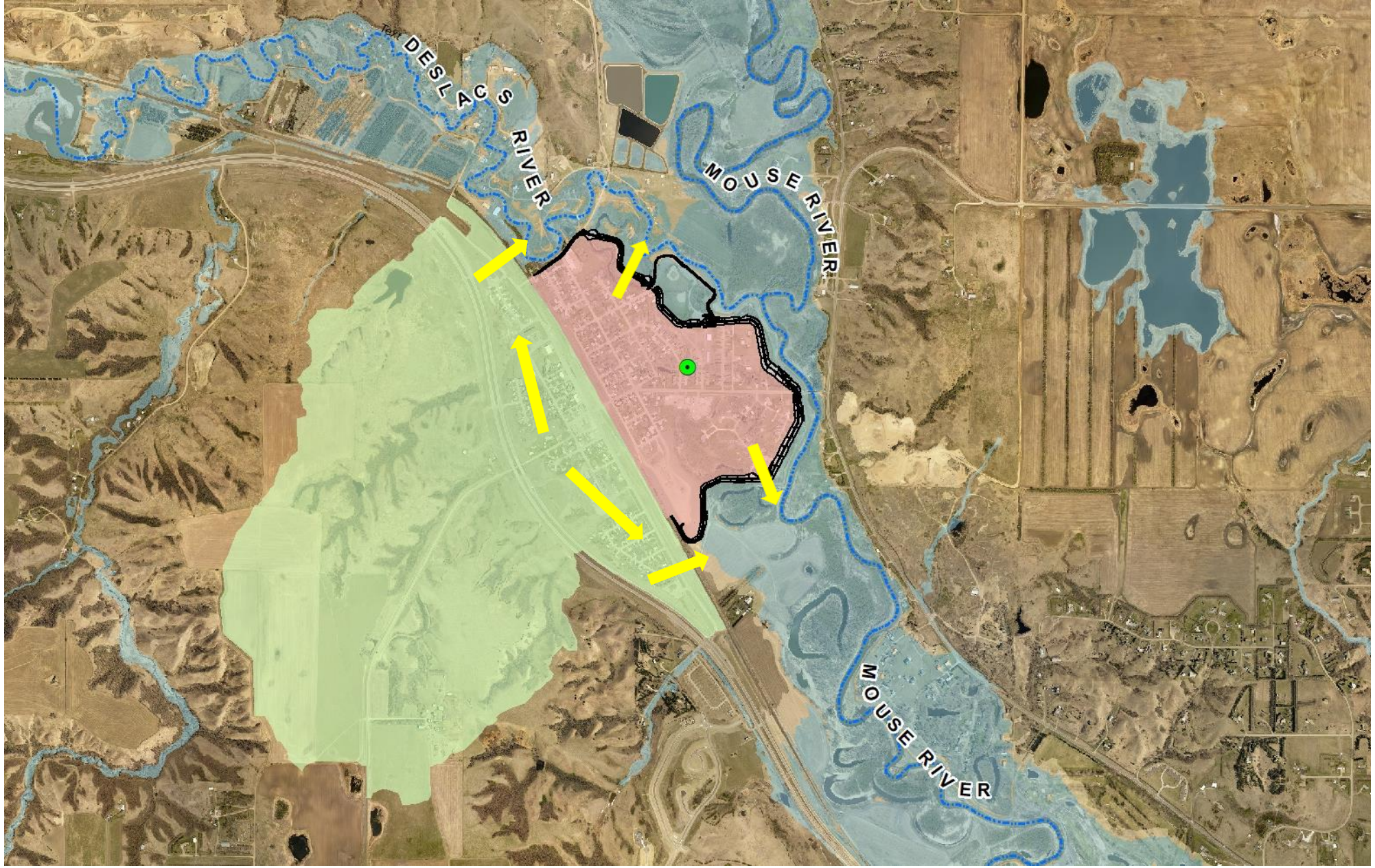
- Protect to 27,000 cfs (44 CFR 65.10 almost an afterthought)
- Offset levee
- Floodwall and levee along Des Lacs River
- Bridge replacement for conveyance

Interior Drainage

- Two gate wells and pump stations
- Existing cutoff meanders for storage



ACKERMAN ESTVOLD



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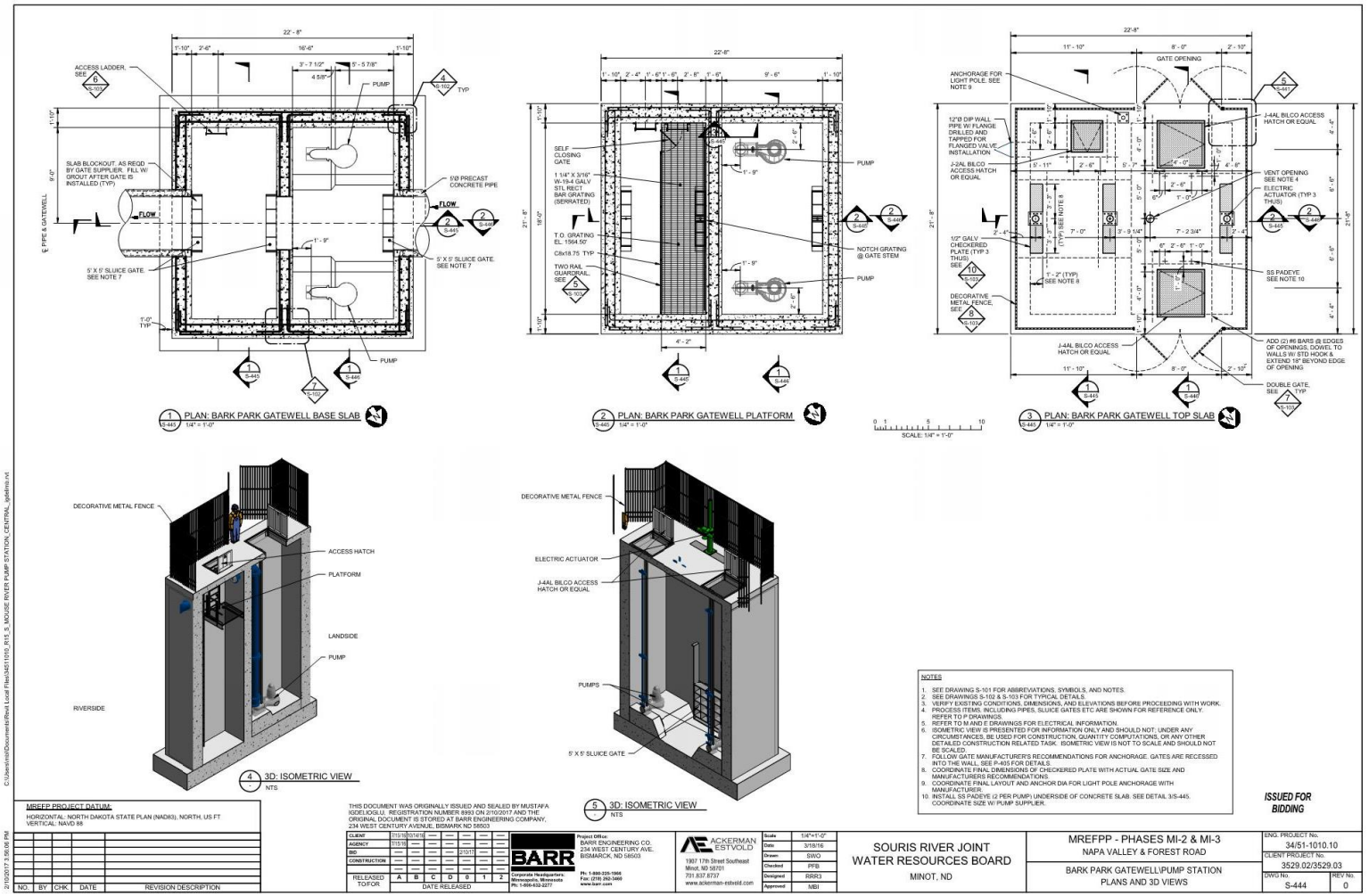
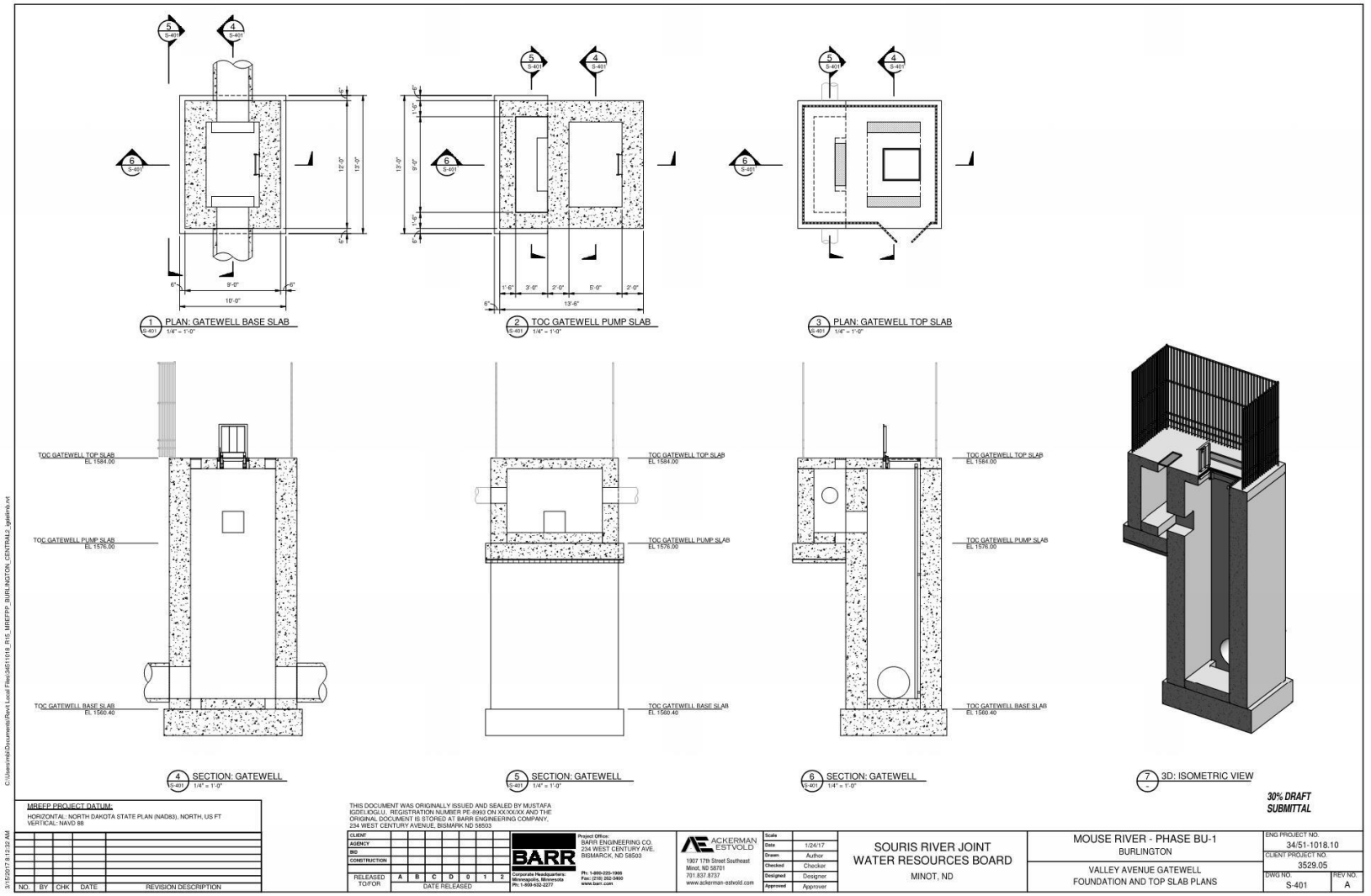
60% Design Considerations

- Gravity discharge during low river stage
- MREFPP minimum design standards (duplex pump station with minimum of 3000 gpm each pump)
- Bark Park combined pump station and gate well in levee
- Redundancy



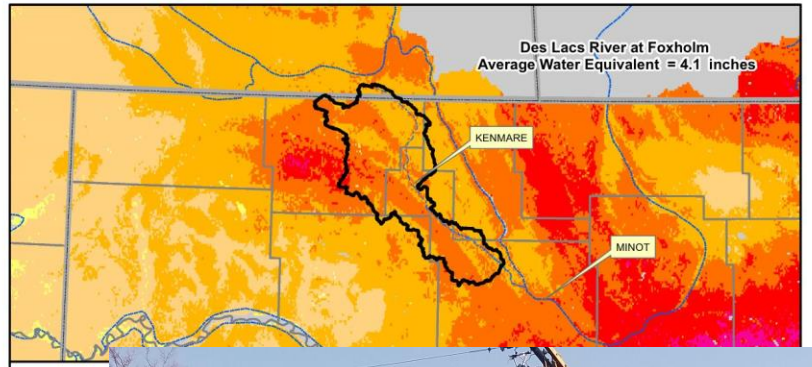
60% Design Considerations

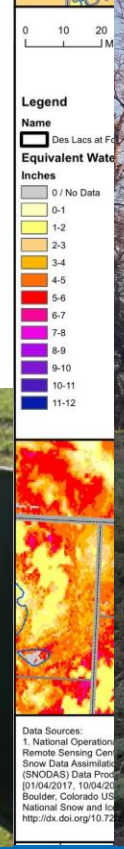
- Stand alone gate well design
- Stand alone pump stations
- Cost: $500,000 each gate well
  $650,000 each pump station
- Complicated operation / redundancy
- Coincident peak usage (14% of the time)



Spring 2017 Operations

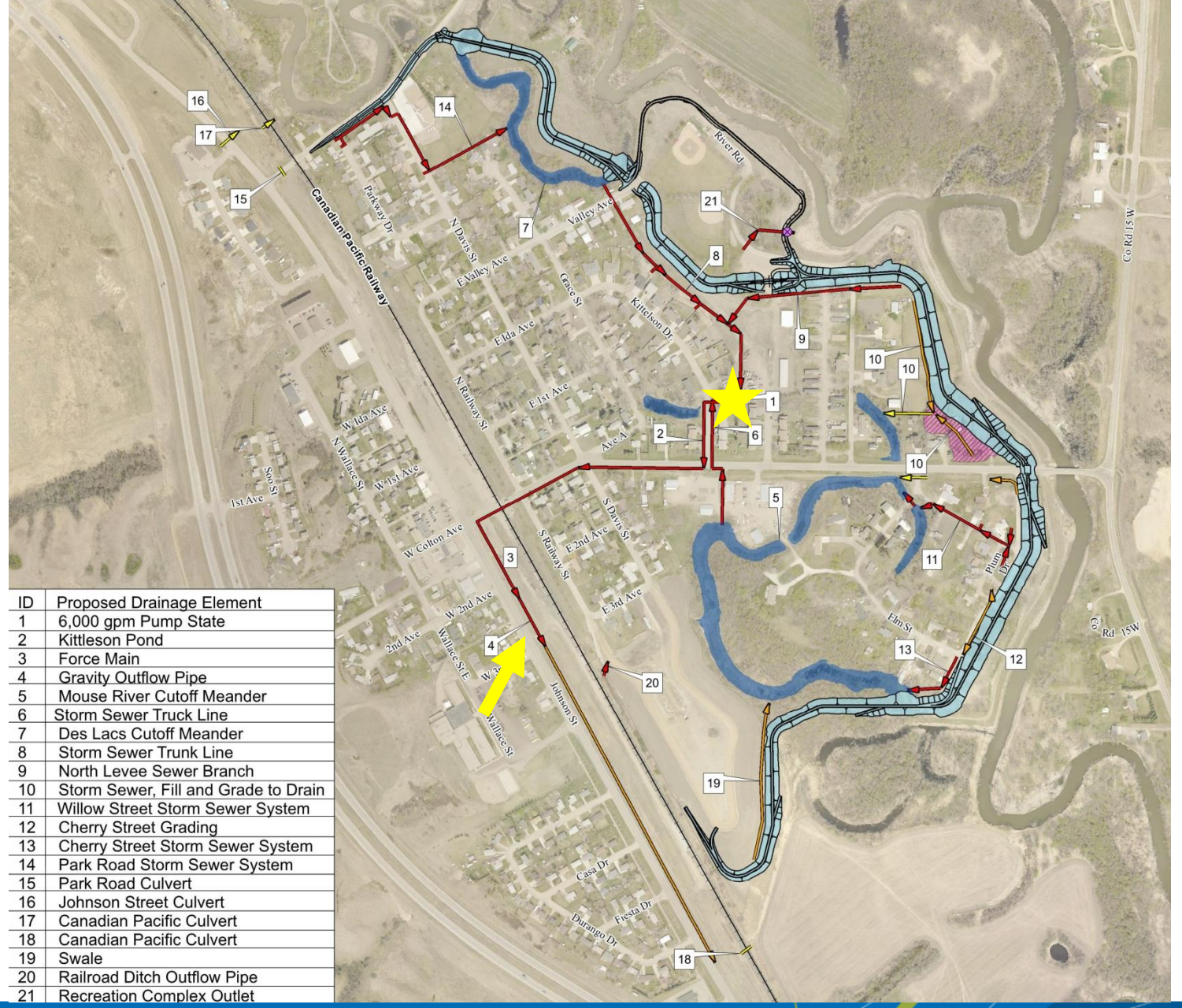
- Large snow pack
- Gate left open
- Interior flooding from the river
- Pump in storage





Is there an alternative?

- Single, centrally located pump station
- Force main, no gravity outlet
- No levee penetrations
- Deeper pump station sump, better storm sewer grades
- Utilize available storage



ID	Proposed Drainage Element
1	6,000 gpm Pump State
2	Kittleson Pond
3	Force Main
4	Gravity Outflow Pipe
5	Mouse River Cutoff Meander
6	Storm Sewer Truck Line
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8	Storm Sewer Trunk Line
9	North Levee Sewer Branch
10	Storm Sewer, Fill and Grade to Drain
11	Willow Street Storm Sewer System
12	Cherry Street Grading
13	Cherry Street Storm Sewer System
14	Park Road Storm Sewer System
15	Park Road Culvert
16	Johnson Street Culvert
17	Canadian Pacific Culvert
18	Canadian Pacific Culvert
19	Swale
20	Railroad Ditch Outflow Pipe
21	Recreation Complex Outlet

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Alternative Cost Analysis

- Lower construction cost ($2,970,000 vs $2,310,000)
- Higher O & M cost ($18,000/year vs $20,000)
- Savings over 60-years ($450,000)
- But value engineering is not just about money

Construction Cost

Item Description	PER (2 Pump Stations) 30% Design Qty	Unit	Unit Price	Extension	Kittelson 60% Design Qty	Unit	Unit Price	Extension
Pump Station (Valley Avenue Pump Station)	1	LS	$ 650,000	$ 650,000			n/a	
Pump Station (Johnson's Addition Pump Station)	1	LS	$ 650,000	$ 650,000			n/a	
Gatewell (Valley Avenue, with Preconsolidation)	1	LS	$ 444,000	$ 444,000			n/a	
Gatewell (Johnson's Addition, with Preconsolidation)	1	LS	$ 394,000	$ 394,000			n/a	
Pump Station (Kittelson)			n/a		1	LS	$ 650,000	$ 650,000
Storm Sewer	1	LS	$ 333,850	$ 333,850	1	LS	$ 1,359,480	$ 1,359,480
Subtotal				$ 2,471,850				$ 2,009,480
Contingency (based on % design completion)	20	%		$ 494,370	15	%		$ 301,422
Total Estimated Construction Cost [1,2,3,4,5,6] 2017 dollars				**$ 2,966,220**				**$ 2,310,902**

Operation and Maintenance Costs

Assumed Design Life: 60 Years

Item Description	Frequency (Years)	PER (2 Pump Stations) 30% Design Qty	Unit	Unit Price	Extension	$/year over 60 years	Kittelson 60% Design Qty	Unit	Unit Price	Extension	$/year over 60 years
Annual Electricity Consumption (2017 cost of electricity assumed, future escalation of electricity cost not included)	1	239.0 88.6 21,175	kW/hr hr/year kW/year	$ 0.105	$ 2,223	$ 2,223	239.0 246.0 58,794	kW/hr hr/year kW/year	$ 0.105	$ 6,173	$ 6,173
Annual Electrical System Maintenance (allowance for 2 trips per year)	1	2	LS	$ 500	$ 1,000	$ 1,000	1	LS	$ 500	$ 500	$ 500
30-Year Replace Pumps (70 hp submersible)	30	2	LS	$ 60,000	$ 120,000	$ 4,000	1	LS	$ 60,000	$ 60,000	$ 2,000
Annual Pump Maintenance (Assume $600 per pump per year)	1	4	Pumps	$ 600	$ 2,400	$ 2,400	2	Pumps	$ 600	$ 1,200	$ 1,200
5-Year Pump Minor Rebuild (for highly used pumps)	5	none					2	Pumps	$ 5,000	$ 10,000	$ 2,000
20-Year Replace Pumps (70 hp submersible)	20	none					2	Pumps	$ 105,000	$ 210,000	$ 3,500
30-Year Replace Pumps (70 hp submersible)	30	4	Pumps	$ 105,000	$ 420,000	$ 7,000	none				
40-Year Replace Pumps (70 hp submersible)	20	none					2	Pumps	$ 105,000	$ 210,000	$ 3,500
Gatewell Maintenance (gate operation, etc. allowance)	1	1	LS	$ 1,000	$ 1,000	$ 1,000	none				
Forcemain Jet Cleaning	5	none					1	LS	$ 5,000	$ 5,000	$ 1,000
Existing Kittelson Pump Station	1	1	LS	$ 500	$ 500	$ 500	none				
Subtotal: Annual O&M [1,2,3,4,5,6]						**$ 18,123**					**$ 19,873**

Life Cycle Cost (No Time Value of Money)

Item Description	PER (2 Pump Stations) 30% Design Qty	Unit	Unit Price	Extension	Kittelson 60% Design Qty	Unit	Unit Price	Extension
Up-Front Construction Cost	1.0	LS	$ 2,966,220	$ 2,966,220	1.0	LS	$ 2,310,902	$ 2,310,902
60 Years Operation & Maintenance (O&M)	60	Years	$ 18,123	$ 1,087,405	60	Years	$ 19,873	$ 1,192,402
Subtotal: Life Cycle Cost [1,2,3,4,5,6] (2017 dollars, time value of money not included)				**$ 4,053,625**				**$ 3,503,304**

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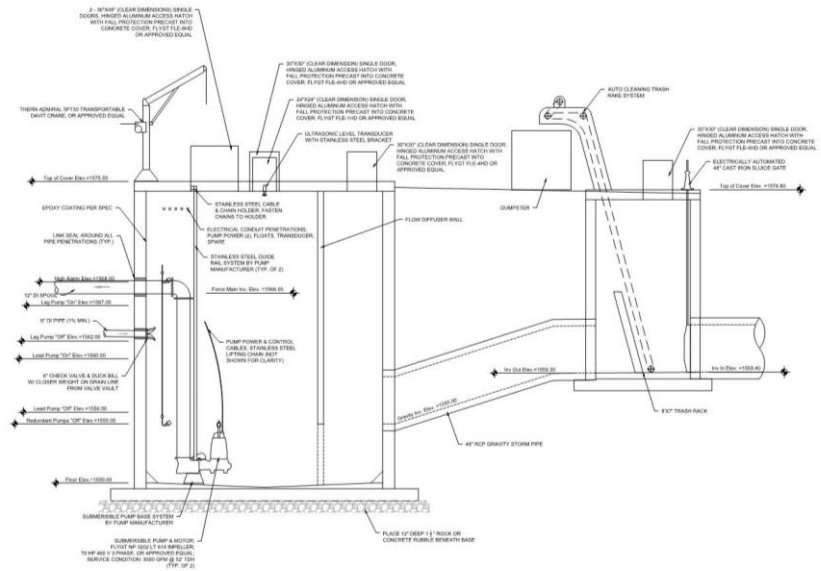
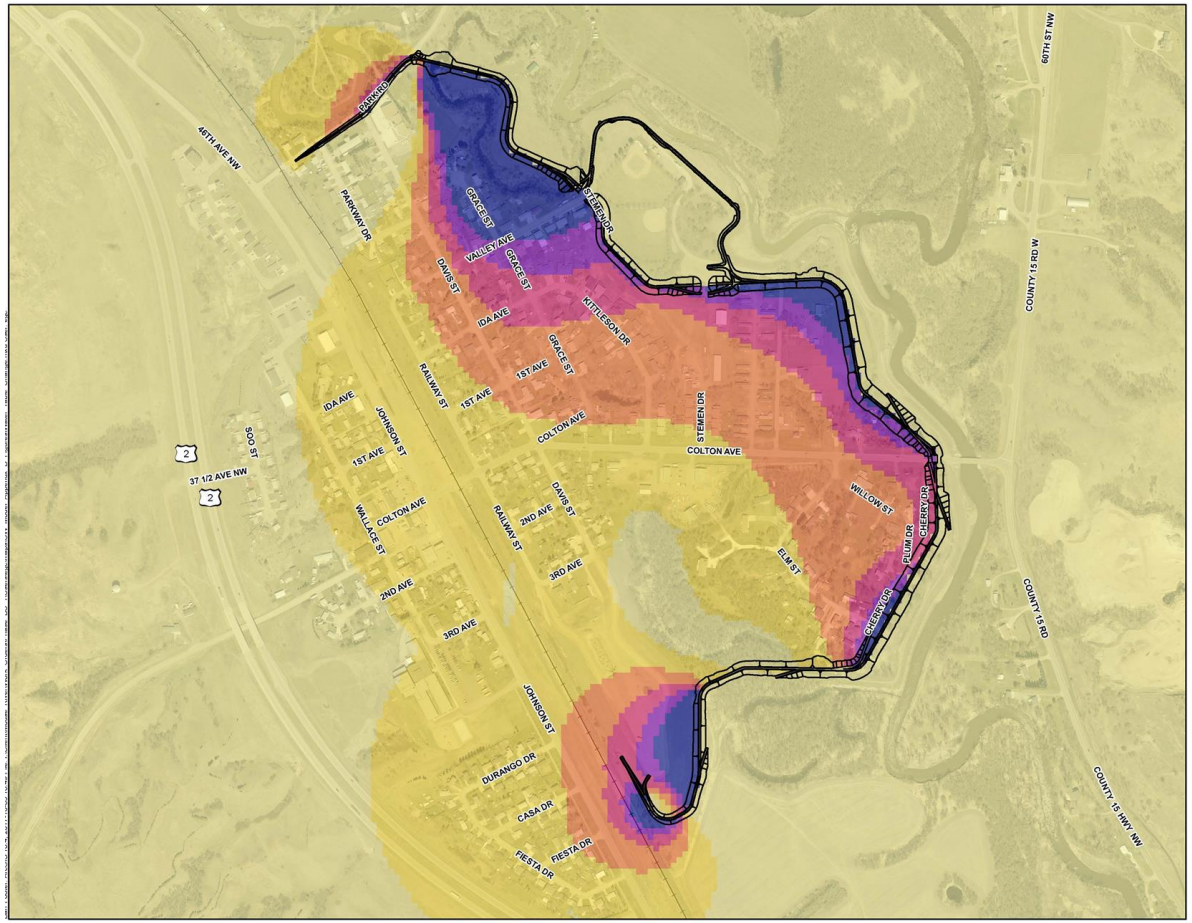
Additional Benefits

- No levee penetrations
- Continuous / consistent operation
  (needed every time it rains)
- May be more reliable
  City staff knows how it works
- Better access to pump station
- Available electrical power

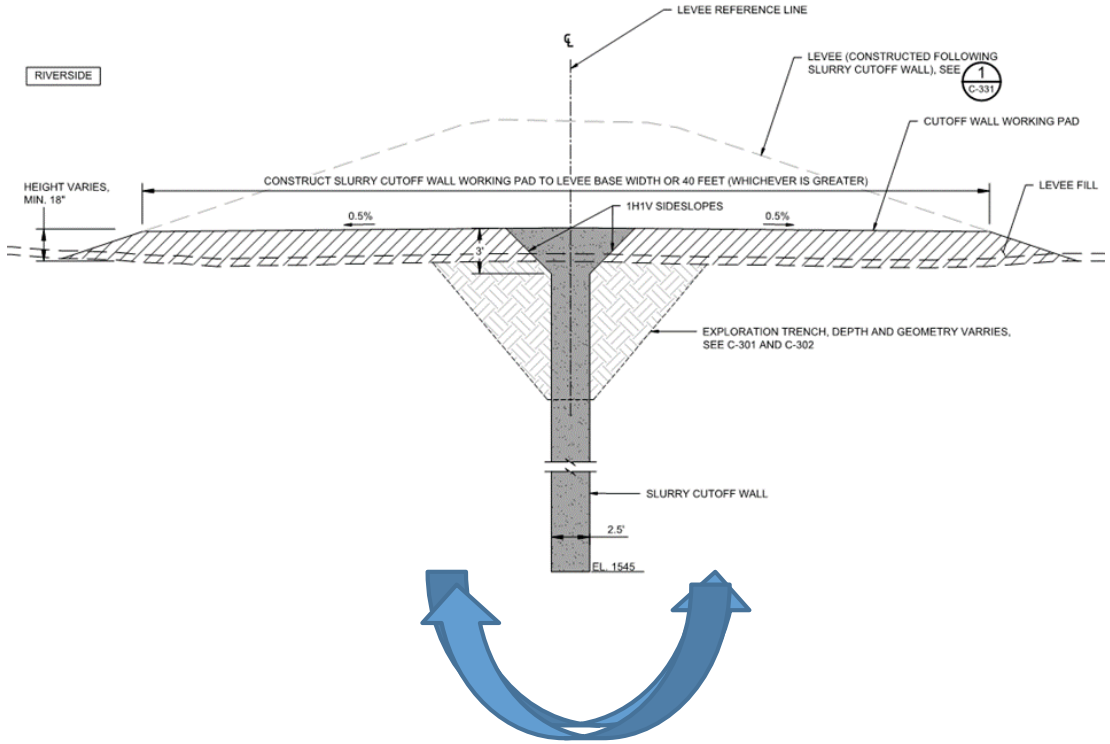


Concerns Being Addressed in Final Design

Groundwater Retention due to Slurry Cutoff Wall

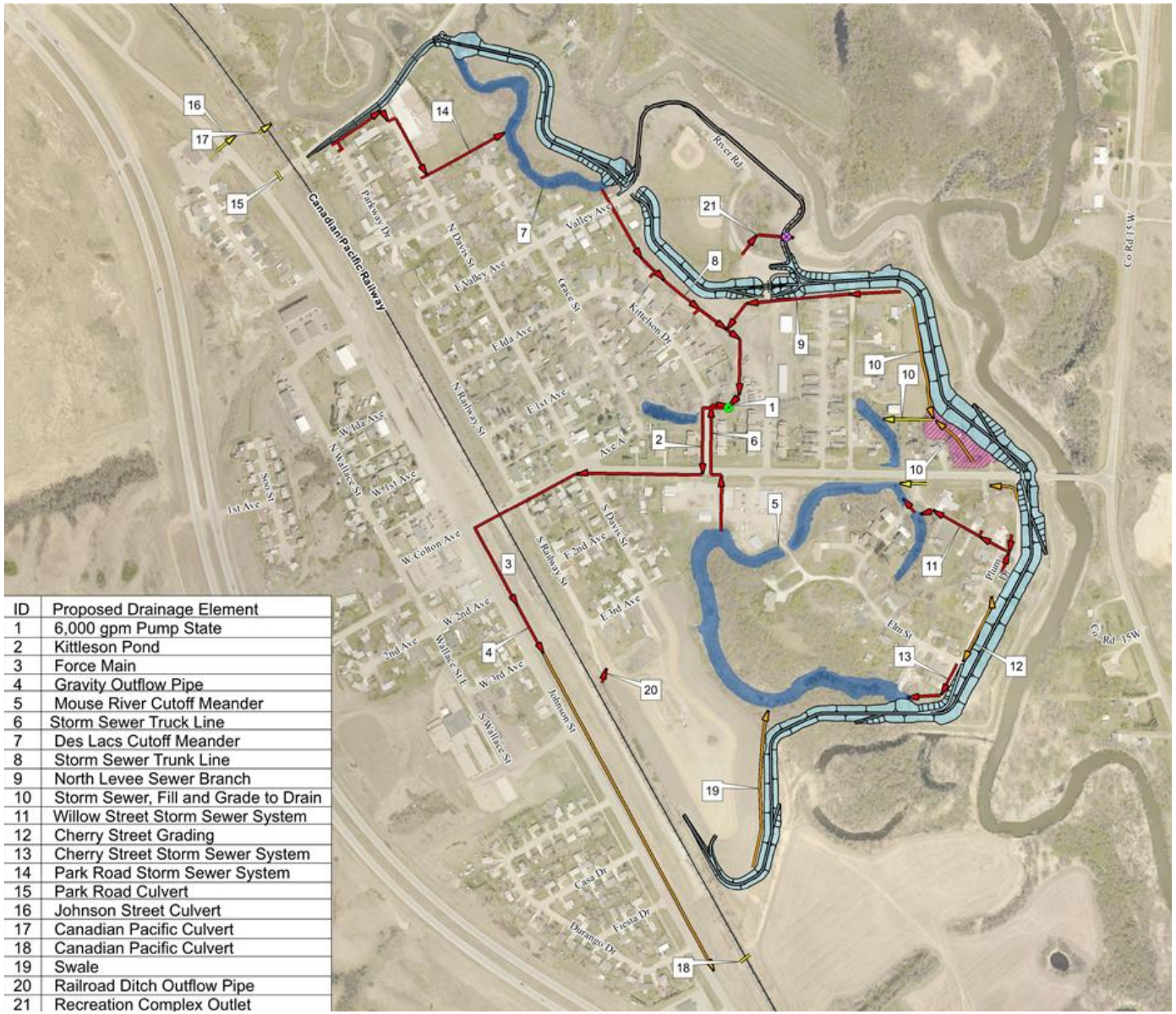


WATER TABLE CHANGE
AS A RESULT OF SLURRY WALL
MREFPP - Phase BU-1
Burlington, ND



Concerns Being Addressed in Final Design

- Winter operations
- Icing concerns



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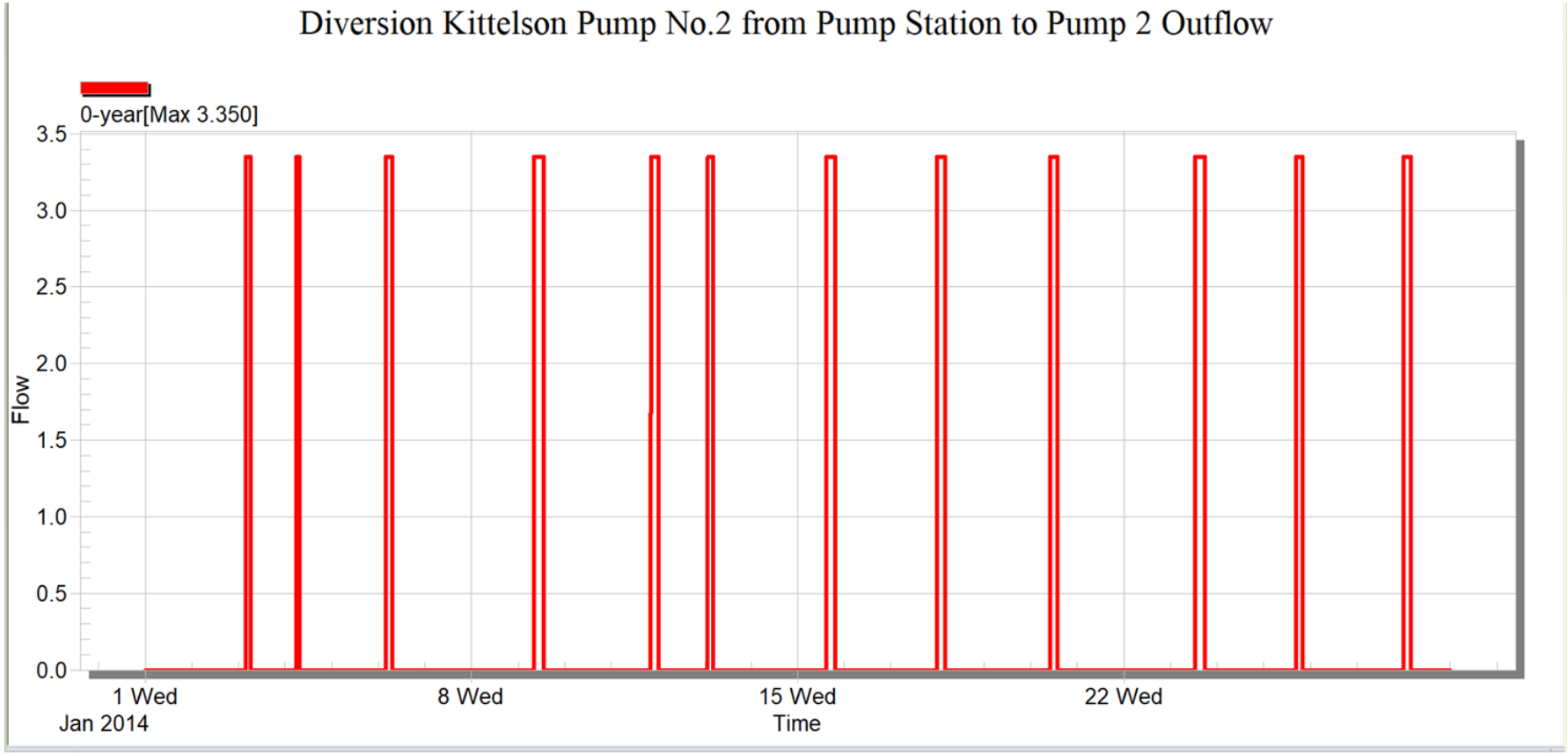
21	Recreation Complex Outlet

Concerns Being Addressed in Final Design

- Winter operations
- Icing concerns
- Throttle down pump
- Change operation
- 48-days of storage

Concerns Being Addressed in Final Design

- Winter operations
- Icing concerns
- Throttle down pump
- Change operation



Questions?

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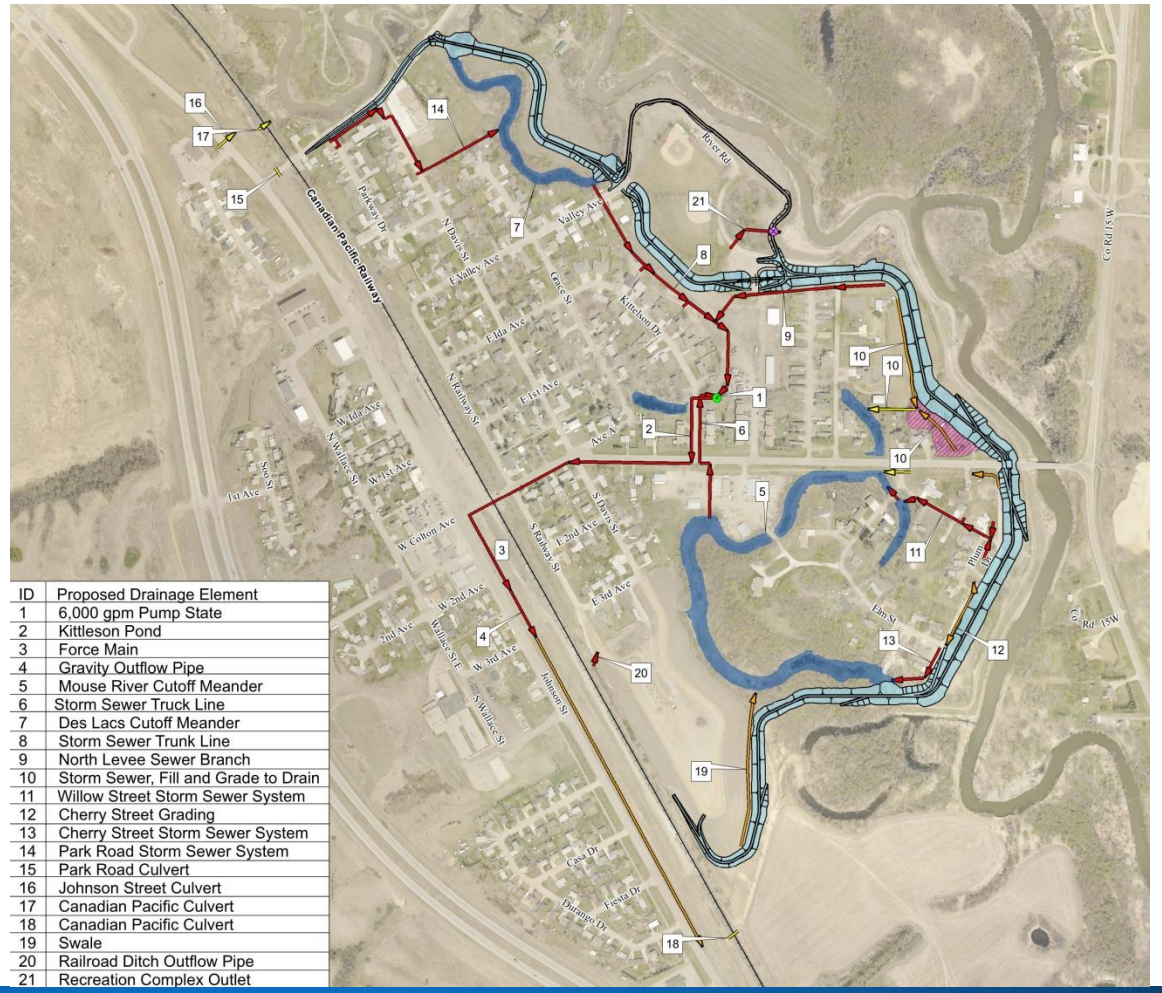

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March 7, 2018 - AMFM

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Interior Drainage Design